Natural Plant Defenses—Fight or Flight?

Lost, you hurry across the dark, empty street but stop short as a threatening figure emerges from the shadows of a nearby alley. A sudden rush of adrenaline shifts your heart rate, breathing, and sugar metabolism into overdrive, readying your muscles for flight—or to fight, if necessary.

An imperiled plant is somewhat like a person in this regard. It, too, relies on built-in safety mechanisms to ensure its well-being. While it can't exactly flee an imminent threat—such as from disease-causing bacteria or a hungry insect—it can fight back. First, however, the plant must know what it is up against, says Jacyn Baker, a plant pathologist at the ARS Molecular Plant Pathology Laboratory in Beltsville, Maryland.

He is studying chemical cues or signals that help plants recognize harmful microorganisms such as *Pseudomonas solanacearum*, a soilborne bacterium that causes brown rot disease in potato crops. From such basic research, Baker hopes to eventually speed or improve the plant's ability to mobilize natural defenses against microintruders like *Psuedomonas* and thus arrest the diseases they cause.

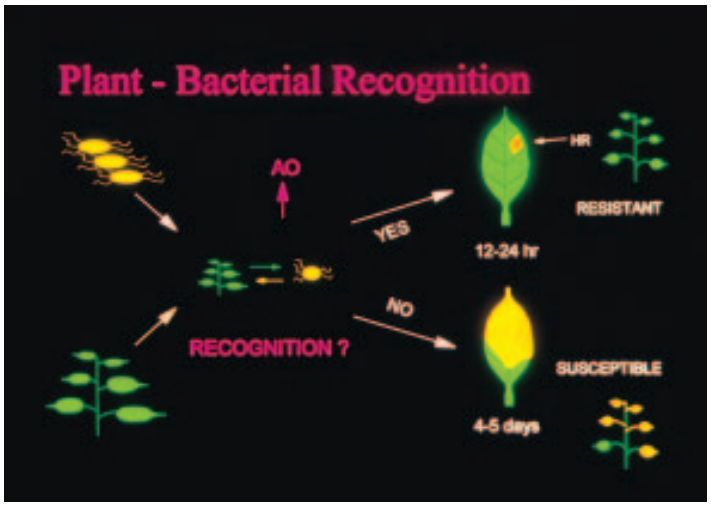
"Plants do have all the means to defend themselves. The key is whether they can trigger these mechanisms or turn them on in time," notes Baker. "Our strategy has been to find the first plant responses that signal recognition of a pathogen and resistance to it."

Plants that hold their own against such threats, he says, would need less of the chemical pesticides growers now use to protect them. In one sense, Baker's plant-signaling work might be likened to a technician adjusting the sensitivity of a home alarm system to deter would-be burglars.

His colleagues on the project are University of Maryland plant pathologist Elizabeth Orlandi and biological lab technician Norton Mock of the Molecular Plant Pathology Laboratory. Their chief focus is a signaling event called the active oxygen (AO) burst. Using a liquid medium of plant callus cells and other lab techniques, they have studied AO bursts in alfalfa, soybeans, tobacco, and most recently, potatoes.

Their work showed that AO is produced in two phases outside of the membranes of plant cells. The second phase, their main interest, is apparently triggered by microorganisms dubbed "incompatible"—essentially those to which the plant is resistant.

One defensive response the AO burst may mediate in plants is the production of lignin, a substance that can impede a pathogen's progress through cell walls. Baker is also investigating whether the burst may induce a plant response called apoptosis—a kind of suicidal cell death in which the cell collapses around the pathogen, trapping it.



When bacteria invade a resistant plant, an active oxygen burst may signal plant cells to produce lignin that slows the bacteria's passage through cell walls. Or it may signal the cells to collapse around and trap the invaders.

"One of our goals is to find out what—if any—value this active oxygen burst might have in the whole scheme of things," says Baker.

Toward that end, his lab is investigating new techniques to accurately measure the duration, intensity, and locale of the signaling event in individual plant cells and tissues.

So far, a promising strategy is to use human oxidase genes as probes to locate genes that regulate AO production in the plants.

Baker's lab is doing the work with Beltsville colleague Frank Turano, who is in the ARS Climate Stress Laboratory. Immunology researchers at the National Institutes of Heath in Bethesda, Maryland, furnish the human oxidase genes for their work.

Pinpointing AO genes in plants may eventually open the door for biotechnology research. If tobacco plants are found to harbor AO-regulating genes that help them recognize a certain pathogen more quickly than soybeans, scientists may then be able to bolster the soybean plant's defensive response by inserting AO-regulating genes borrowed from tobacco, Baker says.—By **Jan Suszkiw**, ARS.

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